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Continent cutaneous diversion

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Continent urinary diversion requires the creation of a reservoir, ureteric implantation and establishment of a continence mechanism in the efferent segment. This review is a short overview on the history of different techniques in current use. Reservoirs with high volume and low pressure can be fashioned by antimesenteric opening and spherical reconfiguration of the bowel. Previously, techniques for ureteric implantation were simply transferred to continent urinary diversion. Currently the need for antirefluxive ureteric implantation techniques is questioned and there is a trend towards refluxive implantation. To create a continence mechanism, simple and reproducible procedures. e.g. the incorporation of the efferent segment into the pouch wall (e.g. appendix stoma, flap valve T mechanism, serosal-lined extramural tunnel) have been developed. Long-term data for different surgical techniques show excellent continence and acceptable complication rates.

KEYWORDS

continent cutaneous diversion, continence mechanism, ureteric implantation, complications

INTRODUCTION

The 19th century was the 'century of urinary diversion'; the initial description of many techniques dates back to the period between 1890 and 1920. As complication rates were high and success rates low in the early period, few patients were treated. Several decades later interest in continent urinary diversion (CUD) was renewed. Improvements in surgical techniques, new instruments/suture materials and the availability of antibiotics and alkalinizing drugs succeeded in tremendously reducing complications during and after surgery.

For CUD, creating a reservoir, ureteric implantation and a continent stoma are required. Different bowel segments have been used to build the reservoir, i.e. ileocaecum, colon (ascending, transverse and descending) and ileum. Other gastrointestinal segments, such as stomach or sigmoid colon, have been mainly considered for bladder augmentation. Detubularization and spherical reconfiguration of the bowel segment used for the reservoir were important steps towards better functionality. Techniques already established for ureteric implantation in ureterosigmoidostomy were simply transferred to cutaneous CUD. The real challenge was the creation of a safe continence mechanism. In this review we provide a short overview of the history and clinical results of important techniques used for cutaneous CUD, with the focus on standard techniques used today in patients with infiltrating bladder cancer.

HISTORY OF SURGICAL TECHNIQUES

ILEO-CAECAL RESERVOIRS

Verhoogen 1908 [1] and Makkas 1910 [2] were the first to use the ileocaecal segment to create a neobladder. Makkas' patient had bladder exstrophy, and the appendix served as a 'neourethra', and thus no real continence mechanism was created. Hinman and Weyrauch [3] stated in 1936 in their review paper on urinary diversion: '. . . implantation to the skin, which perhaps do not serious endanger the life of the patients at the time of operation, permanently place a burden of care and discomfort because of incontinence'. This statement remained true until 1950, when Gilchrist *et al.* [4] successfully used the ileocaecal segment. He rotated the segment by 90°, applied a submucosal Coffey II implantation of the ureters, and used the natural antireflux mechanism of the ileocaecal valve and the peristalsis of the pre-valvular ileal segment, which was used as the efferent segment, as a continence mechanism. Additional support for the efferent segment was gained by its oblique course through the abdominal wall. However, his excellent results could not be reproduced by others, so the search for the ideal technique continued. Other techniques were described in the 1970s; Asken [5] used an ileal segment as a spout valve, and Zingg and Tscholl [6] described a technique of a continent caeco-ileal conduit.

The history of the 'Lundiana Pouch' began in 1977; the caecum served as reservoir and an ileal intussusception nipple as a continence mechanism [7]. Several modifications were later published. In 1986-7, the reservoir consisted of a detubularized segment of ascending colon with the ureters being implanted through submucosal tunnels. An ileal nipple fixed by staples and sutured to the rectus fascia served as continence mechanism (Fig. 1) [8].

The first clinical results in 14 patients were published in 1990 by Mansson *et al.* [9]. Benchekroun [10] developed his 'inkwell valve' in the 1970s and reported on 33 patients in 1980 [11].

The first 'Mainz pouch' (mixed augmentation ileum and caecum) was created in 1983, for bladder substitution to the bladder neck in benign diseases. The first clinical results of 11 patients with bladder substitution and 12 with cutaneous CUD were published in 1986 [12]. The reservoir was created by antimesenteric opening and spherical reconfiguration of the ileocaecal segment. The ureters were implanted using submucosal tunnels as the antireflux mechanism. The

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FIG. 1. The 'Lundiana Pouch.' Ileocaecum and colon are used to create the reservoir. An intussuscepted ileal nipple/ileocaecal valve serves as the continence mechanism [8].

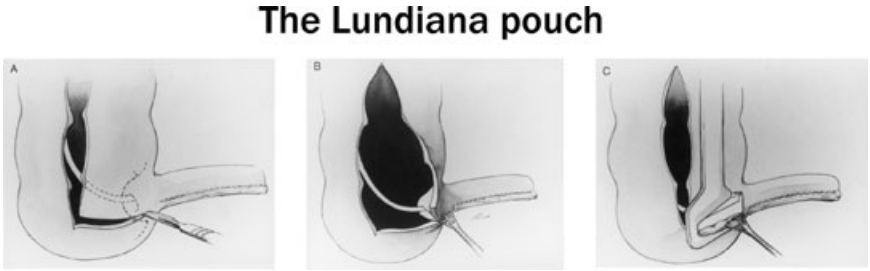
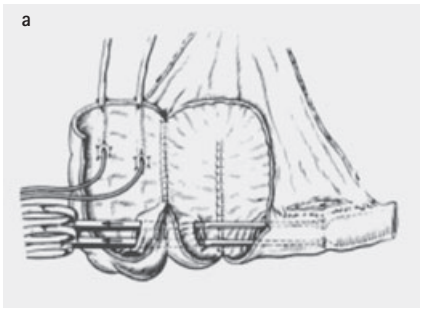
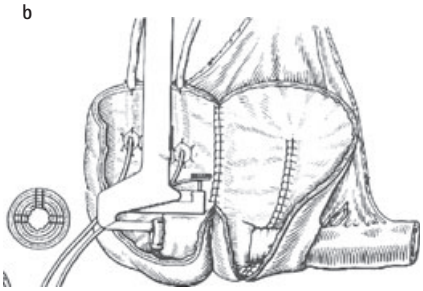
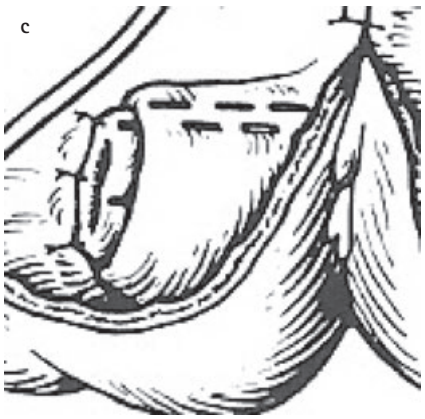


FIG. 3. a, b and c: The Mainz Pouch with ileal nipple: the intussuscepted ileal segment is fixed by two rows of staples; additional pull-through and fixation to the ileocaecal valve by a third row of staples and several sutures [12,14].



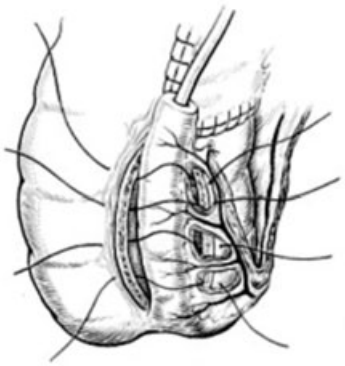




intussuscepted terminal ileum fixed by staples served as the continence mechanism. In 1992 the appendix stoma was introduced [13]; the appendix was submucosally embedded *in situ* into the caecal pole (Fig. 2) [13,14]. The technique of the intussuscepted ileal nipple as a continence mechanism for the Mainz Pouch was also further improved by an additional pull-through of the ileocaecal valve with staple fixation (Fig. 3) [12,14]. Other modifications of the efferent segment, like *in situ* tunnelled bowel flap tubes, were described [15].

In 1985 Rowland *et al.* [16] published the 'Indiana Pouch' method and presented the first clinical results from 29 patients in 1987 [17]. The reservoir was created from the ileocaecum, with the ureters being implanted along the tenia libera. The tapered ileal segment, together with the natural antireflux mechanism of the ileocaecal valve, served as a continence mechanism. Continence was improved by plication sutures (Fig. 4) [17,18]. The 'Florida pouch' was introduced in 1987 and consists of caecum and ascending colon, including the

FIG. 2. The Mainz Pouch with appendix stoma [13,14].



right colonic flexure [19]. The ureters were first implanted using the Le Duc technique, and later by direct refluxing anastomosis. Continence was achieved by the antireflux mechanism of the ileocaecal valve and a double plication of the efferent segment (Fig. 5) [20]. The 'Miami pouch' [21] used the same segments for reservoir creation. They were opened antimesenterically and reconfigured in a U-shape. The ureters were implanted using a modified Le Duc technique. The terminal ileum was tapered and reinforced by three proximal sutures and served as efferent segment (Fig. 6) [22].

TRANSVERSE COLONIC RESERVOIRS

The complication rate is significantly increased when irradiated bowel segments are used for urinary diversion. The technique of the 'transverse pouch (Mainz pouch III)' using bowel segments (transverse and upper ascending or descending colon) outside of the irradiation field was developed for those patients [23,24]. The reservoir is created as an upside-down U. A tailored bowel segment incorporated into the anterior pouch wall serves as continence mechanism.

ILEAL RESERVOIRS

The principle of continent ileostomy is associated with Kock [25], but in 1949 Perl [26] had already described an intussuscepted conical valve formation for jejunostomy. Publications by Basso [27] and Smith and Hinman [28] on the intussuscepted ileal

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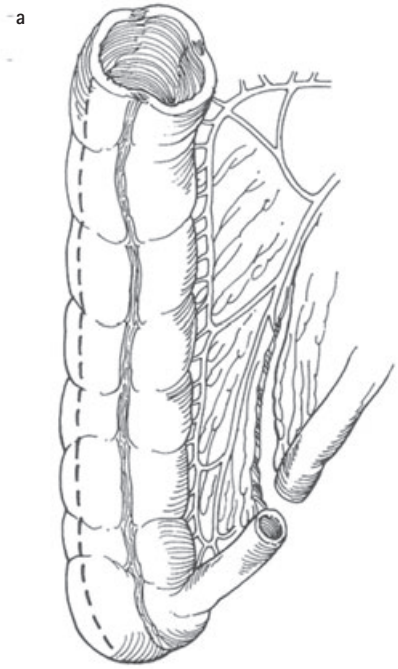
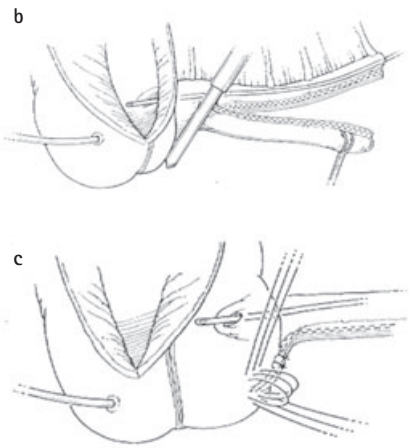
FIG. 4. ***A, B and C****, The Indiana Pouch: the continence mechanism consists of the tailored terminal ileum and additional plication sutures of the ileocaecal valve [17,18].*





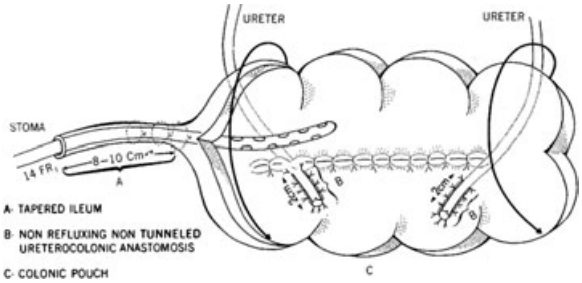


FIG. 6.
The Miami Pouch: U-shaped reservoir created from ileocaecum and ascending colon including the right colonic flexure: tapering of the terminal ileum and reinforcement with 3 sutures [22].

FIG. 5. a and b: The Florida Pouch: continence is achieved by the ileocaecal valve and a double plication of the terminal ileum [20].

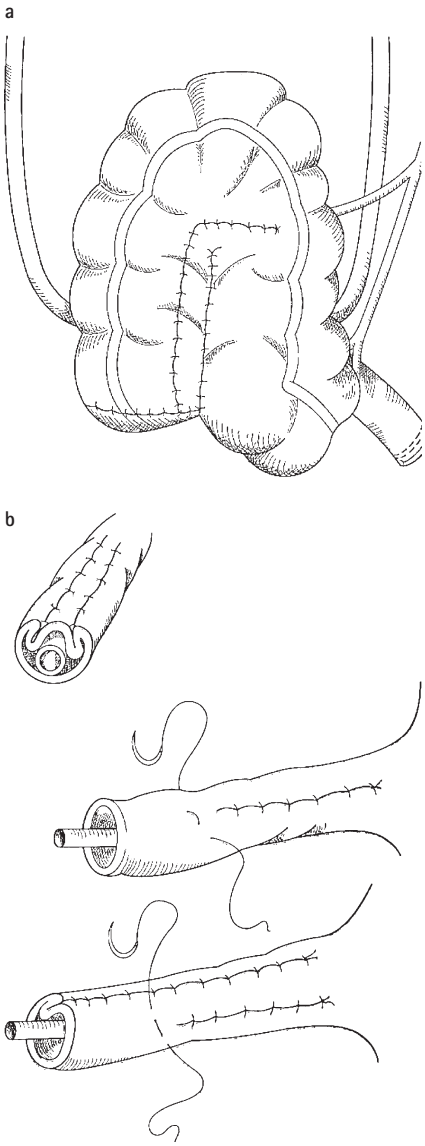


FIG. 7. The continence-achieving valve of the T-pouch [33].

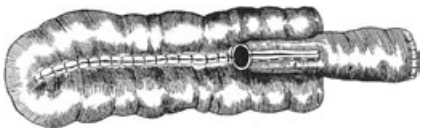
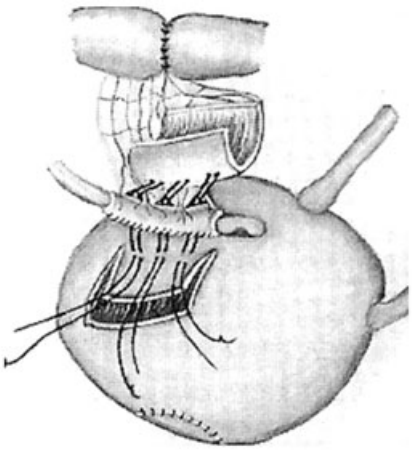


FIG. 8. The serosal-lined extramural valve as the efferent segment and for ureteric implantation [34].



cystostomy followed in the 1950s. It took at least another 20 years until these principles were applied to urinary diversion.

Kock published his work on the ileal reservoir in 1962; he recognized the importance of antimesenteric opening and spherical reconfiguration of the bowel, creating a reservoir 'By splitting the intestine at its antimesenteric border and folding the split intestine twice the motor activity in the different parts of the bladder substitute counteracts itself . . '. In 1969 Kock [25] published the first clinical results with this 'ileal low-pressure pouch' in patients with proctocolectomy. In 1975, he transferred the principle to urinary diversion: the 'Kock pouch' was born. The publication of clinical results followed in 1982 [29]. The ureters were implanted using an intussuscepted ileal nipple as antireflux mechanism (afferent segment). Another intussuscepted ileal nipple served as the efferent segment. Both were reinforced by Marlex tapes. Others, such as Leisinger *et al.*

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TABLE 1 Recent publications on different techniques of cutaneous CUD; complication and continence rates

Technique	Year	No. of patients	Mean follow-up months	Complications % or *n*/*N*		Continence, % or *n*/*N*
				Early	Late	
Lundiana pouch [8]	2003	77	?	12	23	94
Mansoura ileal pouch [34]	2004	109	36.6	16.5	11.8	94.6
Miami pouch [36]	2004	90	?	[53	]	93
				[91 irradiated	]	
Indiana pouch [35]	2005	12	48.5	[10/12 irradiated	]	
		14	40.8	[8/14 unirradiated	]	
Transverse pouch [24]	2007	24	35	4 pouch-related	9	83.8
				16 others		1 pad, 100
Mainz pouch [37]	2006	401	95.0	–	36*	87
Florida pouch [38]	2003	179	<120	–	47.9	93.3

**Uretero-intestinal anastomosis excluded.*

[30] and Madigan [31], also worked on continent ileal reservoirs. Skinner *et al.* [32] published the results for a large series of 531 patients with a Kock pouch in 1989; 10 years later Skinner's team introduced a new technique of an antirefluxive valve mechanism, the 'T-pouch' and no longer used the classical Kock pouch technique (Fig. 7) [33]. Another modification of the ileal continent reservoir was described by Abol-Enein *et al.* [34]; they used a serosal-lined extramural valve as the continence mechanism. The ureters were implanted into a W-shaped ileal reservoir through serosal-lined extramural tunnels (Fig. 8) [34].

RESULTS

Table 1 [23,34–38] summarizes some of the more recent publications. The continence rates are excellent with all techniques, but there are significantly many complications as the follow-up increases; the overall complication rate is 28.3–57%. Excluding those with a transverse pouch [24], irradiated patients have significantly more complications [35,36]. Early pouch-related complications are urinary leakage from the uretero-intestinal anastomosis, or partial pouch necrosis/perforation, early uretero-intestinal anastomotic stricture, and pyelonephritis [8,34].

Common pouch-related late complications include stomal stenosis, stones in the reservoir, catheterizing difficulties, incontinence, and stenosis of the uretero-intestinal implantation. Stomal stenosis is a common complication associated with the efferent segment. Wiesner *et al.* [37] reported on 977 patients with a Mainz pouch cutaneous CUD performed at two institutions. There was stomal stenosis in 23.5% of patients with an appendix stoma and in 15.3% with an intussuscepted ileal nipple. The incidence of calculi was 10.8% in reservoirs with an intussuscepted ileal nipple and 5.6% in reservoirs with an appendix stoma. The overall continence rate was 92.8% (appendix stoma 96%, ileal nipple 89%). Abol-Enein *et al.* [34] reported stomal stenosis in 5% and stones in another 5.4% of patients with the Mansoura ileal reservoir and the serosal-lined extramural valve as the continence mechanism. Two patients failed to catheterize themselves. The Florida pouch [38] was associated with stomal stenosis during the follow-up in 4% of patients; there was intractable urinary incontinence in 6.7%, and one patient (1.6%) had difficulties in catheterizing. Reservoir stones developed in 5.4%.

The incidence of uretero-intestinal obstruction depends on the technique used for ureteric implantation. Mansson *et al.* [8] described a 2.4% obstruction rate with the Le Duc technique. An obstruction of the afferent nipple was reported in 4% of patients with a Kock pouch [39]. Wiesner *et al.* [37] compared the outcome of two different techniques: the submucosal tunnel (809 renal units) and serosal-lined extramural tunnel (74 renal units); there was stenosis in 7.3 and 4.1%, respectively. Abol-Enein *et al.* [34] reported a stenosis rate of 5.2% with the serosal-lined extramural tunnel. The complication rate of the T afferent limb was investigated in patients with an orthotopic T-pouch ileal bladder [40]. The upper tract study was abnormal in 10% of 209 patients, including nine with ureteroileal obstruction and four with afferent-limb stenosis. Again, irradiated ureters had a higher rate of stenosis (20–42%) [35,36], with the exception of the transverse colonic pouch (4%) [24]. However, the follow-up in the series with a transverse colonic pouch was much shorter.

DISCUSSION

Infiltrating bladder cancer is the main indication for urinary diversion; at most institutions orthotopic neobladder reconstruction currently represents the primary method of CUD in patients with infiltrating bladder cancer. When the urethra is involved, cutaneous CUD indicated. Some authors also recommend cutaneous CUD in patients with carcinoma *in situ* [8]. In females, creating an orthotopic neobladder is feasible, but with a long-term follow-up, up to half will require clean intermittent catheterization to empty the neobladder. Catheterization through a continent abdominal stoma is easier than self-catheterization through the urethra, especially for obese patients.

Selection criteria for continent reconstruction are age, mental status, kidney function and health status. Age is a relative contraindication; the upper limit is usually 75–80 years. The patient should be compliant and mentally capable of using self-catheterization and correctly interpreting the symptoms of a full reservoir. Patients with

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advanced disease will most likely not benefit from CUD in terms of quality of life. If kidney function is low (serum creatinine <150 μmol/L), incontinent diversion is usually recommended.

The ideal reservoir should be spherical and with low pressures at high capacity. The choice of bowel segments for cutaneous CUD is mostly a question of personal preference. However, large bowel, due to its larger diameter, requires less bowel resection, has no malabsorption sequelae (all of which derive from ileum resection) and especially the ileocaecal region offers advantages for creating a continence mechanism. Irradiated patients benefit from the use of transverse colon, as this is located outside the irradiation field [23,24]. Continent pouches are prone to stone formation. Risk factors are foreign body material (metal staples), residual urine, bacteriuria, hypercalciuria and hypocitraturia. Reservoir perforation or rupture is a very rare complication in cutaneous CUD [8].

Complications of the uretero-intestinal anastomosis occur in all forms of CUD and depend more on the implantation technique used than on the type of CUD. The debate continues as to whether antirefluxive ureteric implantation is necessary. There is a trend towards direct refluxing implantation, as complications caused by reflux seem to be less harmful than those caused by obstruction. As the typical patient with bladder cancer is generally older and has limited life-expectancy, reflux of the uretero-intestinal anastomosis might not be of clinical relevance. However, as long as prospective long-term data are lacking, no conclusive recommendation can be given.

Reconstruction of a safe, simple and reproducible continence mechanism was the real challenge in the past. The use of the appendix or the (tapered) terminal ileum as an efferent segment is simple. The incorporation of the efferent segment into the pouch wall is safe and reproducible [13,33,34]. Complex techniques, e.g. the intussuscepted nipple, have only survived at high-volume centres [37]. Stomal stenosis is the main complication of the efferent segment. The smaller the diameter of the efferent segment, the higher the incidence of stenosis. Stenosis can be treated endoscopically by incision in most patients. An acknowledged disadvantage of the endoscopic incision is the higher recurrence rate of stenosis [37].

CONCLUSION

Many of the problems that occurred during the creation of continent cutaneous reservoirs in the past have been solved. Reservoirs with high volume and low pressures can be fashioned by antimesenteric opening and spherical reconfiguration of the bowel. The need for antirefluxive ureteric implantation is questioned and there is a trend towards refluxive implantation. Simple and reproducible techniques such as the incorporation of the efferent segment into the pouch wall (appendix stoma, flap-valve T mechanism, serosa lined extramural tunnel) have been developed for creating a continence mechanism. Long-term data on different surgical techniques show excellent continence and acceptable complication rates.

CONFLICT OF INTEREST

None declared.

REFERENCES

1 **Verhoogen J.** Neostomie uretero-cecale. Formation d'une poche vesicale et d'un noveau urètre. *Assoc Franc d'Urol* 1908; **12**: 352–65
2 **Makkas M.** Zur Behandlung der Blasenekstrophie: Umwandlung des ausgeschalteten Zökums zur Blase und der Appendix zur Urethra. *Zentralbl Chir* 1910; **37**: 1073–6
3 **Hinman F, Weyrauch HM Jr.** A critical study of the different principles of surgery which have been used in ureterointestinal implantation. *Trans Am Assoc Genitourin Surg* 1936; **29**: 15–6
4 **Gilchrist RK, Merricks JW, Hamlin MH, Rieger IT.** Construction of a substitute bladder and urethra. *Surg Gynecol Obstet* 1950; **90**: 752–60
5 **Ashken MH.** An appliance-free ileocecal urinary diversion: preliminary communication. *Br J Urol* 1974; **46**: 631–8
6 **Zinng E, Tscholl R.** Continent cecoileal conduit: preliminary report. *J Urol* 1977; **118**: 724–8
7 **Mansson W, Sundin T.** Experience with a continent caecal reservoir in urinary diversion. *Scand J Urol Nephrol* 1978; **48** (Suppl.): 4
8 **Mansson W, Davidsson T, Könyves J, Liedberg F, Mansson A, Wullt B.** Continent urinary tract reconstruction – the Lund experience. *BJU Int* 2003; **92**: 271–6
9 **Mansson W, Davidsson T, Colleen S.** The detubularized right colonic segment as urinary reservoir: evolution of technique for continent diversion. *J Urol* 1990; **144**: 1359–61
10 **Benchekroun A.** Continent caecal bladder. *Eur Urol* 1977; **3**: 248–50
11 **Benchekroun A.** Vessie iléocoecale continente: à propos de 33 cas. *Chirurgie* 1980; **106**: 668–72
12 **Thüroff JW, Alken P, Riedmiller H, Jacobi GH, Hohenfellner R.** The Mainz pouch (mixed augmentation ileum and cecum) for bladder augmentation and continent diversion. *J Urol* 1986; **136**: 17–26
13 **Riedmiller H.** Appendix as continent urinary reservoir outlet. *Scand J Urol Nephrol* 1992; **142** (Suppl.): 73–5
14 **Thüroff JW, Alken P, Riedmiller H, Jacobi GH, Hohenfellner R.** 100 cases of Mainz pouch: continuing experience and evolution. *J Urol* 1988; **140**: 283–8
15 **Lampel A, Hohenfellner M, Schultz-Lampel D, Thüroff JW.** In situ tunneled bowel flap tubes: 2 new techniques of a continent outlet for Mainz pouch cutaneous diversion. *J Urol* 1995; **153**: 308–15
16 **Rowland RG, Mitchell ME, Bihrle R.** The cecoileal continent urinary reservoir. *World J Urol* 1985; **3**: 185–90
17 **Rowland RG, Mitchell ME, Bihrle R, Kahnoski RJ, Piser JE.** Indiana continent urinary reservoir. *J Urol* 1987; **137**: 1139
18 **Rowland RG, Kropp BP.** Evolution of the Indiana continent urinary reservoir. *J Urol* 1994; **152**: 2247–51
19 **Lockhart JL.** Remodeled right colon: an alternative urinary reservoir. *J Urol* 1987; **138**: 730–4
20 **Lockhart JL, Pow-Sang JM, Persky L, Kahn P, Helal M, Sanford E.** A continent colonic urinary reservoir: the Florida pouch. *J Urol* 1990; **144**: 864–7
21 **Bejany DE, Politano VA.** Stapled and nonstapled tapered distal ileum for construction of a continent colonic urinary reservoir. *J Urol* 1988; **140**: 491–4
22 **Bloch WE, Bejany DE, Penalver MA, Politano VA.** Complications of the Miami pouch. *J Urol* 1992; **147**: 1017–9
23 **Leissner J, Black P, Fisch M, Höckel M, Hohenfellner R.** Colon pouch (Mainz

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pouch III) for continent urinary diversion after pelvic irradiation. *Urology* 2000; **56**: 798–802
24 **Stolzenburg JU, Eschwalenberg T, Liatsikos EN *et al.*** Colon pouch (Mainz III) for continent urinary diversion. *BJU Int* 2007; **99**: 1473–7
25 **Kock NG.** Intraabdominal 'reservoir' in patients with permanent ileostomy. Preliminary observations on a procedure resulting in fecal 'continence' in five ileostomy patients. *Arch Surg* 1969; **99**: 223–31
26 **Perl JI.** Intussuscepted conical valve formation for jejunostomies. *Surgery* 1949; **25**: 297
27 **Basso R.** The efficacy and applicability of an intussuscepted conical valve in preventing regurgitation and leakage of intestinal contents. *Ann Surg* 1951; **133**: 477–85
28 **Smith GI, Hinman F Jr.** The intussuscepted ileal cystostomy. *J Urol* 1955; **73**: 261–9
29 **Kock NG, Nilson AE, Nilsson LO, Norlén LJ, Philipson BM.** Urinary diversion via a continent ileal reservoir: clinical results in 12 patients. *J Urol* 1982; **128**: 469–75
30 **Leisinger HJ, Säuberli H, Schauwecker H, Mayor G.** Continent ileal bladder: first clinical experience. *Eur Urol* 1976; **2**: 8–12
31 **Madigan MR.** The continent ileostomy and the isolated ileal bladder. *Ann R Coll Surg Engl* 1976; **58**: 62–9
32 **Skinner DG, Lieskovsky G, Boyd S.** Continent urinary diversion. *J Urol* 1989; **141**: 1323–7
33 **Bochner BH, Stein JP, Ginsberg DA, Kurzrock E, Figueroa A, Skinner DG.** A serous lined antireflux valve: in vitro fluoro-urodynamic evaluation of antireflux continence mechanism. *J Urol* 1998; **160**: 112–5
34 **Abol-Enein H, Salem M, Meshbah A *et al.*** Continent cutaneous ileal pouch using serous lined extramural valves. The Mansoura experience in more than 100 patients. *J Urol* 2004; **172**: 588–91
35 **Wilkin M, Horwitz G, Seetharam A *et al.*** Long-term complications associated with the Indiana pouch urinary diversion in patients with recurrent gynecologic cancers after high dose irradiation. *Urol Oncol* 2005; **23**: 12–5
36 **Salom EM, Mendez LE, Schey D *et al.*** Continent ileocolonic urinary reservoir (Miami pouch): the University of Miami experience over 15 years. *Am J Obstet Gynecol* 2004; **190**: 994–1003
37 **Wiesner C, Stein R, Pahernik S, Hähn K, Melchior SW, Thüroff JW.** Long-term followup of the intussuscepted ileal nipple and the in situ, submucosally embedded appendix as continence mechanisms of continent urinary diversion with the cutaneous ileocecal pouch (Mainz pouch I). *J Urol* 2006; **176**: 155–9
38 **Webster C, Bukkapatnam R, Seigne JD *et al.*** Continent colonic urinary reservoir (Florida pouch): long-term surgical complications (greater than 11 years). *J Urol* 2003; **169**: 174–6
39 **Stein JP, Freeman JA, Esrig D, Elmajian DA, Tarter TH, Skinner DG.** Complications of the afferent antireflux valve mechanism in the Kock ileal reservoir. *J Urol* 1996; **155**: 1584
40 **Stein JP, Dunn MD, Queck ML, Miranda G, Skinner DG.** The orthotopic T pouch ileal neobladder: experience with 209 patients. *J Urol* 2004; **172**: 584–7

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Abbreviation: **CUD**, continent urinary diversion.

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